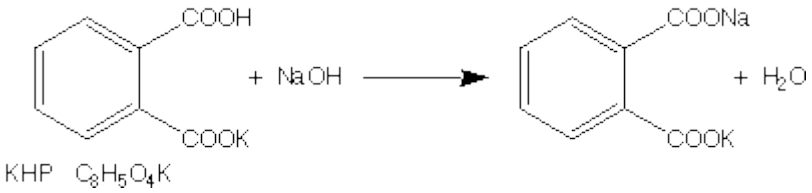
Standardization of NaOH Solution by Colorimetric Titration

Objective: You will understand how to perform a standardization titration and then use the results to find the pH of Apple Juice

Background

Sodium hydroxide is very difficult to accurately measure using a balance because it attracts water molecules from the surrounding air. Titration is a method of reacting a solution of unknown concentration (the NaOH in this lab) with one of known concentration. This lab will use a crystalized acid called potassium hydrogen phthalate (KHP) as the compound of known concentration. By comparing the amount of NaOH solution needed to completely react a known amount of KHP, the concentration of the NaOH solution can be determined.

KHP and NaOH react according to the balanced chemical equation below:



Pre- Lab Questions

1: What is the ratio of NaOH to KHP in the reaction above?

2: How many moles of NaOH will react with 0.5 moles of KHP?

3: What type of reaction is this?

4: KHP's chemical formula is $C_8H_5KO_4$. What is the molar mass of KHP?

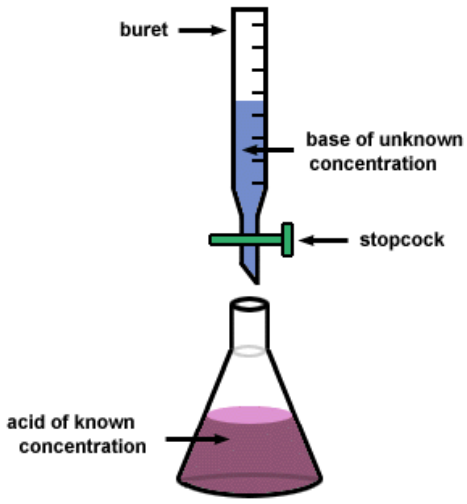


Figure 1

In this titration, you will be placing a known quantity of KHP (dissolved in water) into a flask as shown in figure 1. You will be adding NaOH to the KHP solution until all of the KHP has been used up in a neutralization reaction.

5: Is the pH of the KHP solution in the flask acidic or basic?

6: How will we know when all of the KHP is used up?

In this lab, you will conduct a **colorimetric titration** which means that a color changing indicator (phenolphthalein) will be used to show changes in the pH. As KHP is reacted with NaOH, the pH will slowly rise. There will be a point where all of the KHP has reacted and you will not have added any more NaOH than was needed to react with the KHP. This is called the **equivalence point**. At this point, the pH of the solution should be the same as the pH of water with a salt in it. This is a neutral solution that would have a pH of 7. Phenolphthalein is colorless in acidic solution and pink in basic solutions. At the equivalence point the solution should be a very, very faint pink color but the color should be throughout the solution and it

should stay for at least 20 seconds. Eventually the pink color will fade as CO_2 is dissolved in the water making the water slightly more acidic.

7: What should you see in your solution when you have reached the equivalence point?

It is often good to do some pre-planning that will help you later in the lab. If you can start out with an idea of how much NaOH solution would be needed to react with a given mass of KHP you should be able to have a better idea of how much of each compound you will be working with.

8: How much KHP would react completely with 15mL of 0.1M NaOH?

9: **With only units, write out how you can calculate moles of NaOH reacted from the mass of KHP.**

PLEASE CHECK YOUR RESULTS WITH YOUR TEACHER BEFORE MOVING ON

Materials

- Potassium hydrogen phthalate (KHP)
- ~0.1 M sodium hydroxide (NaOH)
- Phenolphthalein indicator solution
- 125/250 mL Erlenmeyer flask
- 50 mL buret
- Analytical balance

Procedures

Part I: Standardization on NaOH with KHP

Make a table to contain all of the data collected during the lab. (A suggestion ↓)

Trial #	Mass KHP	Initial Volume NaOH	Final Volume NaOH	Volume NaOH Used
1				
2				
3				
4				

1. Clean an Erlenmeyer flask as thoroughly as you canwith water [DO NOT USE SOAP as it will leave a residue that is slightly basic that will interfere with your results.] It is not important to dry the inside of the flask…just get as much water out as possible.

2. In the flask, mass out the amount of KHP calculated in your answer to Pre-lab Question 8 above. ***RECORD YOUR ACTUAL MASS IN YOUR DATA TABLE TO 0.01g!!!!! Skipping this will void the trial.***

3. Add 30-50 mL of water to the flask and swirl until all of the KHP is dissolved. Check the sides of the flask to make sure that all KHP crystals are making it into the solution.

4. Add 2-3 drops of the phenolphthalein solution to the flask and swirl to mix.

5. Add ~ 50mL of ~0.1M NaOH to your buret and flush glass nipple with NaOH into waste beaker to clear air bubble. Record the initial volume of NaOH in the buret on your data table. **If you skip this step, you will have to start over!**

6. Titrate NaOH from the buret until you reach the equivalence point.

- At the beginning you can add NaOH very quickly. Remember that you calculated you KHP as enough to react with 15mL of NaOH. Those values were approximate so they won't be perfect but they should be close. Gently swirl the flask to mix.
- When you get close to the equivalence point you want to add NaOH much more slowly and in much smaller quantities. You can add drop by drop until you are very close. Gently swirl the flask to mix.
- When you feel you are just a few drops from the equivalence point, you should begin adding fractions of a drop which can be done by just barely opening the stopcock until a drop is visible and hanging on the buret tip. You can wash the drop into the flask with a wash bottle filled with DI water. Gently swirl the flask to mix.

7. When you have reached the equivalence point, record the volume of NaOH in the buret on your data table. You can use the initial and final volumes to calculate the volume of NaOH used.

8. Repeat these procedures for 3-4 trials and calculate the molarity of NaOH from each trial. In the end, you will need three trials that give calculated NaOH molarities that are within 1.0% of each other. You will likely need to conduct more trials in order to get three runs that are close enough together to satisfy this requirement.

Part II: Analysis of Apple juice

Trial #	Volume Juice	Initial Volume NaOH	Final Volume NaOH	Volume NaOH Used
1				
2				
3				
4				

1. Refill your buret to between the 0 and 5mL mark with the ~0.1M NaOH (you, should know the exact Molarity after Part I).

2. Add 10mL of apple juice to an erlymyer flask along with 2-3 drops of phenolpathien and 15mL of DI water.

3. Titrate the apple juice with the NaOH until equivalence point (slight peach/ orange color).

4. Dispose of down drain and repeat or a total of 2-4 trials.

Calculations Part I

1. You will need to calculate the number of moles of NaOH reacted in each of the flasks using the calculation that you worked out in Pre Lab Question 9.

2. Calculate the molarity of NaOH for all of your runs. **SHOW YOUR CALCULATIONS!** Choose your best three runs and **label them.**

3. Put your results from the best three runs in a table like the one below. Calculate the average molarity of NaOH from the three runs and finish error calculations:

SHOW ALL WORK FOR YOUR CALCULATIONS!!! DO <u>NOT</u> JUST PUT DATA INTO THE TABLE

Trial #	NaOH reacted (mol)	Molarity NaOH (mol/L)	Average Molarity (mol/L)	Difference from Avg.	Percent Error
1					
2					
3					

M = moles solute/L solution

Difference from Average = $|M_{run} - M_{average}|$

Percent Error = (Difference from Avg. / Average Molarity)·100

Part II

1. Using the molarity of the NaOH and the volume dispensed find Molarity $[H^+]$ of the juice ($M_aV_a = M_bV_b$

2. Find the average molarity of the H^+ in your juice sample.

3. Calculate the pH of your juice from your average molarity of H^+.

4. Put info in table like one below

Trial #	Molarity $[H^+]$ in Juice	Average Molarity (mol/L)	pH of Juice
1			
2			
3			
4			

Post Lab Questions

1. What is the purpose of completing a standardization of the NaOH in this lab?

2. List three (3) errors or mishaps you made or may have made that influenced your results?

3. What do you think the acid is in the juice, if you do not know research this online for an answer?

4. Look up the pH of your juice (find a range) online. Are you within the range?

5. What could cause your pH to differ if it was not in the range? If it was in the range, what could cause a juice to not be within the range? Think experiment error and natural changes to the juice.